

Amendments to the Specification:

Please replace the paragraph, beginning at page 1, line 11, with the following rewritten paragraph:

The present invention relates to a magneto-optical recording medium for recording or erasing information by utilizing an increase in temperature caused by irradiation with laser light and for reading a recorded signal by utilizing a magneto-optical effect; a method of manufacturing the magneto-optical recording medium; a method of recording on the magneto-optical recording medium; and a method of reproduction from the magneto-optical recording medium.

Please replace the paragraph, beginning at page 1, line 21, with the following rewritten paragraph:

Optical memories capable of reproduction of information by detecting reflected light from a irradiated light beam. Types of optical memories include a read-only memory (ROM) ~~type of memory~~ in which information is recorded as phase pits, and a write once type of optical memory in which holes are formed in a recording film by irradiation with a light beam to record information. Other types include a phase change type of optical memory in which a crystalline phase in a recording film is changed by irradiation with a light beams to record information, and a magneto-optical memory in which the direction of magnetization of a recording layer is changed by irradiation with a light beam and application of a magnetic field to record information.

Please replace the paragraph, beginning at page 3, line 3, with the following rewritten paragraph:

The ~~entire~~ disclosure in Japanese Patent Laid-Open No. 6-290496 is incorporated herein by reference in its entirety.

Please replace the paragraph, beginning at page 5, line 14, with the following rewritten paragraph:

The present invention can provide a magneto-optical recording medium capable of improving the recording density and the transfer rate in magneto-optical recording, a method of manufacturing the magneto-optical recording medium, a method of recording on the magneto-optical recording medium, and a method of reproduction from the magneto-optical recording medium, ~~and is therefore useful.~~

Please replace the paragraph, beginning at page 23, line 9, with the following rewritten paragraph:

As shown in Fig. 1, the recording film having the above-described magnetic films in a multilayer structure is formed on the optical disk substrate 11. Land portions are formed on opposite sides of a groove in the optical disk substrate 11. The depth h of the groove in a rectangular form is 60 nm from the upper surface of the land portions. In the magneto-optical disk 10 of Embodiment 1, the track pitch is substantially 0.7 μm and the groove width is substantially 0.55 μm .

Please replace the paragraph, beginning at page 23, line 17, with the following rewritten paragraph:

A $\text{ZiS}\cdot\text{SiO}_2$ target is mounted in a magnetron sputtering apparatus and a transparent optical disk substrate 11 formed of polycarbonate and having a groove formed therein is fixed on a substrate holder. Thereafter, the interior of the chamber is evacuated to a high vacuum of substantially 5×10^{-6} Pa or less by a cryopump. In the evacuated state, Ar gas is introduced into the chamber until substantially 0.5 Pa is reached. Film of $\text{ZiS}\cdot\text{SiO}_2$ is formed as the dielectric layer 12 to a thickness of substantially 75 nm by radiofrequency sputtering while the substrate is being rotated.

Please replace the paragraph, beginning at page 28, line 18, with the following rewritten paragraph:

In Embodiment 1, the arrangement is more advantageous if the track pitch is substantially 1.0 μm or less; land portions are formed in such a configuration as to have a width substantially in the range from 0.2 to 0.8 μm between grooves in which information is recorded; and recording magnetic domains are formed such that the shortest mark length of recorded information is substantially 200 nm or less.

Please replace the paragraph, beginning at page 29, line 4, with the following rewritten paragraph:

A different arrangement capable of obtaining similar reproduction characteristics is possible if a recording layer having a column configuration having a structural unit of a width substantially within the range from 1 to 40 nm (more preferably, within the range from 2 to 15 nm) is formed on a under layer which functions as a nucleus for forming a columnar structure, and if the film thickness of the recording layer is not smaller than substantially 50 nm (more preferably, in the range from 60 to 200 nm).

Please replace the paragraph, beginning at page 30, line 15, with the following rewritten paragraph:

In Embodiment 1, the film structure of the recording layer 15 has a column configuration and the stability of microscopic magnetic domains therein is improved. Therefore, even a

recording magnetic domain of a mark length of substantially 100 nm can be stably transferred into the reproduction layer 13 and the domain wall of the transferred magnetic domain can be displaced.

Please replace the paragraph, beginning at page 30, line 23, with the following rewritten paragraph:

Indeed, with respect to the case of using an optical disk substrate having substantially a track pitch of 0.7 μm and a groove width of 0.55 μm , as illustrated, it can be understood that a magneto-optical disk in which substantially no change is caused in the carrier level if the mark length of substantially 100 nm is not exceeded, can be realized by effecting separation of magnetization of the recording film between grooves by land portions.

Please replace the paragraph, beginning at page 31, line 20, with the following rewritten paragraph:

However, the same effects can be achieved with respect to magneto-optical recording mediums of a configuration in which the relationship between the height and width of land portions is such that the track pitch is substantially within the range from 0.4 to 1.0 μm , the groove width is substantially within the range from 0.2 to 0.8 μm , and the groove depth is substantially within the range from 20 to 200 nm, and in which the recording layer is formed by adjusting the seed layer and the grain growth layer according to the groove configuration.

Please replace the paragraph, beginning at page 32, line 4, with the following rewritten paragraph:

In a case where the height of land portions between grooves in which information is recorded is small, substantially $\lambda/20n$ to $\lambda/3n$ (n : a refractive index, the same symbol used below), the optical disk substrate can be easily formed and noise from grooves can be reduced.

Please replace the paragraph, beginning at page 32, line 9, with the following rewritten paragraph:

In the arrangement of Embodiment 1, as described above, microscopic magnetic domains of substantially 200 nm or less are formed with stability in a recording film having a columnar structure capable of rewriting recorded information, thereby ensuring the desired domain wall mobility.

Please replace the paragraph, beginning at page 33, line 16, with the following rewritten paragraph:

Assuming the laser wavelength is λ , if the height of land portions between grooves in which information is recorded may be substantially within the range from $\lambda/20n$ to $\lambda/3n$, or λ may be substantially within the range from 20 nm to 180 nm, the optical disk substrate can be easily formed and noise from grooves can be reduced.

Please replace the paragraph, beginning at page 38, line 1, with the following rewritten paragraph:

Specifically, the reproduction layer 23 in the three-layer structure formed of GdFeCoCr can be formed in an amorphous film structure having a microscopic grain structure unit of substantially 1.0 nm or less by deposition lamination by setting a substrate rotational speed of 300 rpm, a film forming Ar pressure of 0.5 Pa and a film forming rate of 10 nm/sec.

Please replace the paragraph, beginning at page 38, line 7, with the following rewritten paragraph:

Each of the control layer 24 formed of TbFeCoCr having thickness of 10 nm and the intermediate layer 25 formed of TbDyFeCr film having thickness of 15 nm can be formed as an amorphous magnetic thin film having a structural unit of substantially 2.0 nm or less by setting a substrate rotational speed of 100 rpm, a film forming Ar pressure of 3.0 Pa and a film forming rate of 5 nm/sec.

Please replace the paragraph, beginning at page 39, line 12, with the following rewritten paragraph:

The other portion of the recording film having a thickness of 70 nm is formed by setting a film forming Kr gas pressure of 4.5 Pa and a film forming rate of 10 nm/sec to form the recording film-26, which is a magnetic thin film in a columnar structure formed of columns having a structural unit width of 20 nm.

Please replace the paragraph, beginning at page 40, line 22, with the following rewritten paragraph:

However, the described columnar structure is not exclusively used. An arrangement in which the recording layer has a structural unit having a width in the range from substantially 2 to 40 nm may suffice. The thickness of the recording layer may be substantially 50 nm or more (more preferably, in the range from 60 to 200 nm).

Please replace the paragraph, beginning at page 41, line 3, with the following rewritten paragraph:

With respect to the under layer for nucleus formation for forming a columnar structure, it is desirable that the film thickness be substantially within the range from 5 to 50 nm (more preferably, within the range from 5 to 20 nm).

Please replace the paragraph, beginning at page 41, line 7, with the following rewritten paragraph:

Also, if the film thickness of the second under layer for controlling the column width in the columnar structure is substantially within the range from 5 to 50 nm (more preferably, within the range from 5 to 20 nm), a magneto-optical disk capable of obtaining high-density recording/reproduction characteristics can be realized.

Please replace the paragraph, beginning at page 41, line 13, with the following rewritten paragraph:

If the second under layer has a structural unit substantially in the range from 2 to 40 nm, the column width in the recording layer can be controlled more effectively.

Please replace the paragraph, beginning at page 42, line 6, with the following rewritten paragraph:

In Embodiment 2, the arrangement is more advantageous if the track pitch is substantially 1.0 μm or less; land portions are formed between grooves having a groove width in substantially the range from 0.2 to 0.8 μm ; and an information signal having a mark length of substantially 300 nm or less at the minimum.

Please replace the paragraph, beginning at page 43, line 3, with the following rewritten paragraph:

Further, the linear velocity is 2.4 m/sec. In a case where signals are recorded and reproduced by optical pulse magnetic field modulation recording, each of the reproduction power and the recording power is within substantially a range of $\pm 20\%$ or more.

Please replace the paragraph, beginning at page 43, line 14, with the following rewritten paragraph:

A columnar structure having a structural unit width of substantially 5 nm or more can be formed if the first under layer provided as a nucleus for forming the columnar structure is

formed by using a manufacturing method in which the pressure at the time of film forming of the first under layer is lower than that at the time of film forming of the second under layer for controlling the grain width of columns in the recording layer (more specifically, a manufacturing method in which the gas pressure in the vacuum chamber when the first under layer provided as a nucleus for the columnar structure is within substantially the range from 0.2 Pa to 3 Pa, and the gas pressure when the second under layer and the recording layer are formed is within the range from 1.5 Pa to 6 Pa).

Please replace the paragraph, beginning at page 44, line 3, with the following rewritten paragraph:

By considering the Ar flow rate and evacuation rate at the time of film forming, the gas pressure may be set to substantially 0.3 to 1.5 Pa for the first under layer and to within substantially the range from 2.5 Pa to 4.5 Pa for the second under layer and the recording layer to achieve an equal or higher effect.

Please replace the paragraph, beginning at page 44, line 8, with the following rewritten paragraph:

Preferably, in such a case, the Ar flow rate is maximized within a range determined by the capacity of the vacuum pump. It is preferable to introduce Ar at a rate of substantially 20 SCCM (standard cubic centimeters per minute) or higher.

Please replace the paragraph, beginning at page 44, line 22, with the following rewritten paragraph:

The shortest limit mark length in the recording layer depends on the vertical magnetic anisotropy. However, recording and reproduction to a mark length of substantially 100 nm or less can be performed if a columnar structure is formed, as in Embodiment 2, and if the product ($M_s H_c$) of the magnetization and the coercive force is set to substantially 1.5×10^6 or greater and a vertical magnetic anisotropy constant K_u is set to substantially 5×10^5 erg/cm³ or greater (more preferably, 1×10^6 erg/cm³ or greater).

Please replace the paragraph, beginning at page 45, line 10, with the following rewritten paragraph:

The same effect can be obtained if the content of Ar atoms in the magnetic thin film is within the range substantially from 0.5 to 4.0 mol%.

Please replace the paragraph, beginning at page 45, line 20, with the following rewritten paragraph:

In particular, for the purpose of forming a columnar structure having a structural unit of a size in substantially the range from 5 to 40 nm, it is desirable to form the under layers as a thin film having a density of substantially 2.0 to 5.0 g/cm³ at room temperature.

Please replace the paragraph, beginning at page 45, line 24, with the following rewritten paragraph:

An amount of Ar atoms equal to or larger than substantially 0.5 mol% is contained also in the ~~the~~ recording layer. Further, the same effect can be obtained if Ne, Kr or Xe is contained in the under layer and in the recording layer.

Please replace the paragraph, beginning at page 46, line 3, with the following rewritten paragraph:

It is desirable that the surface roughness Ra relating to surface irregularities of the first under layer be set within the range from 0.1 to 1.5 nm (more preferably, within substantially the range from 0.1 to 1.0 nm). The second under layer and the columnar film structure of the recording layer can be formed on the fine irregularities functioning as a nucleus.

Please replace the paragraph, beginning at page 46, line 9, with the following rewritten paragraph:

The construction using fine surface irregularities having a roughness of substantially 1 nm or less has the effect of enabling domain walls coming nearer to the reproducing light beam to be smoothly displaced in the case of a recording and reproduction method using a domain wall displacement method such as DWDD.

Please replace the paragraph, beginning at page 46, line 15, with the following rewritten paragraph:

Consequently, to improve the signal characteristics of the magneto-optical recording medium according to the DWDD method, the film thickness of each of the first and second under layers may be set to a value substantially in the range from 5 to 50 nm (more preferably, in the range from 5 to 20 nm) and the column width in the column configuration in the recording layer may be set to substantially a value in the range from 2 to 40 nm (more preferably, in the range from 5 to 20 nm). It can be understood that a sufficiently stable vertical magnetic anisotropy of the film surface can be obtained to enable the same high-density recording/reproduction even in the case of recording a short mark of 100 nm or less.

Please replace the paragraph, beginning at page 47, line 3, with the following rewritten paragraph:

As can be understood from jitters in signal reproduction, the minimum of film thickness of the recording layer is within substantially the range from 100 to 180 nm.

Please replace the paragraph, beginning at page 47, line 6, with the following rewritten paragraph:

An optimum value of the film thickness, depending on the film composition and magnetic characteristics of the recording layer, may relatively be large in the case of the recording layer having a column configuration structure, such that the formation of the columnar structure can be facilitated. The film thickness of the recording layer may be set to a value within substantially the range from 40 to 300 nm (more preferably, within the range from 80 to 200 nm) to ensure that recording magnetic domains can be formed with stability even to a short mark length by using the columnar structure and can be transferred into the reproduction layer. It can be understood that recording magnetic domains can be thereby formed even to mark length of substantially 100 nm or less.

Please replace the paragraph, beginning at page 47, line 24, with the following rewritten paragraph:

An arrangement using a under layer and having a columnar structure in the recording layer (more specifically, the column width in the column configuration in the recording layer is within substantially the range from 2 to 40 nm, more preferably from 5 to 20 nm) is provided to ensure the desired mobility of magnetic domain walls.

Please replace the paragraph, beginning at page 48, line 5, with the following rewritten paragraph:

Thus, the reproduction signal can be increased by displacing transferred magnetic domains on the basis of the DWDD method without performing annealing on portions between recording tracks, even when the mark length is substantially 200 nm or less.

Please replace the paragraph, beginning at page 55, line 4, with the following rewritten paragraph:

In actuality, the dropout rate can be reduced by changing the current density for the seed layer at the time of sputtering. More specifically, the dropout rate can be effectively reduced at a film forming rate corresponding to a current density in substantially the range from 20 to 80 A/cm².

Please replace the paragraph, beginning at page 55, line 9, with the following rewritten paragraph:

For example, 1.E-01 indicates that defects occur at a rate of substantially 0.1 (that is, 10% of recorded marks are not recorded or the recorded marks are changed in size) and the defective recording marks cannot be detected as a normal recording mark.

Please replace the paragraph, beginning at page 56, line 1, with the following rewritten paragraph:

For the function of the seed layer capable of forming a column configuration, a columnar structure can be formed at a film forming rate substantially within the range from 0.2 to 5 nm/sec (more preferably, within substantially the range from 0.4 to 3 nm/sec corresponding to the above-described current density range from substantially 20 to 80 A/m²).

Please replace the paragraph, beginning at page 56, line 10, with the following rewritten paragraph:

Thus, the column width in the column configuration in the recording layer is set to substantially 5 nm or greater to enable stable recording/reproduction to a mark length of substantially 100 nm or less. In addition, recording magnetic domains are stably formed and recorded by a recording/reproduction method using thermal assistance with a waveguide or the like and using a magnetic head such as a GMR head, and a signal is reproduced.

Please replace the paragraph, beginning at page 57, line 6, with the following rewritten paragraph:

As described above, the magneto-optical recording medium of Embodiment 3, by virtue of the structure with a under layer, has a construction in which a columnar film structure is provided in a recording layer, more specifically a construction in which a recording layer having a column configuration of a structural unit width substantially in the range from 2 to 40 nm (more preferably, in the range from 5 to 20 nm) is formed.

Please replace the paragraph, beginning at page 57, line 13, with the following rewritten paragraph:

If the recording layer is formed so that its film thickness is substantially 50 nm or more (more preferably, 60 to 200 nm), the stability of recording magnetic domains can be improved and improved reproduction signal characteristics can be obtained even when the mark length is short.

Please replace the paragraph, beginning at page 62, line 15, with the following rewritten paragraph:

The track pitch of the optical disk substrate of this embodiment is substantially 0.5 to 0.8 μm , and the groove width is substantially 0.4 to 0.6 μm .

Please replace the paragraph, beginning at page 62, line 22, with the following rewritten paragraph:

Also, grooves or land portions having a width of substantially 0.2 to 0.8 μm may be formed between lands or grooves where information is recorded, such that shutoff is effected between the recording tracks and the track pitch is substantially 1.0 μm or less.

Please replace the paragraph, beginning at page 65, line 11, with the following rewritten paragraph:

The embodiments have been described with respect to the recording film structure in which the reproduction layer, the control layer, the intermediate switching layer and the recording layer or like layers are combined, and in which the film thickness of the reproduction layer and the recording layer is 30 to 60 nm and the film thickness of the control layer and the intermediate switching layer is substantially 5 to 15 nm.

Please replace the paragraph, beginning at page 65, line 18, with the following rewritten paragraph:

However, this film structure is not exclusively used. The film thickness may be set within substantially the range from 5 to 200 nm to obtain a magnetic coupling force between the recording layer and the reproduction layer large enough to satisfy the characteristics in accordance with the present invention.

Please replace the paragraph, beginning at page 65, line 23, with the following rewritten paragraph:

More preferably, for example, the thickness of the reproduction layer is set substantially within the range from 10 to 100 nm, the thickness of the control layer substantially within the range from 5 to 50 nm, the thickness of the intermediate switching layer substantially within the range from 5 to 50 nm, and the thickness of the recording layer substantially within the range from 30 to 200 nm.

Please replace the paragraph, beginning at page 66, line 12, with the following rewritten paragraph:

The column structure forming layer may be such that the amount of Ar gas taken in is substantially 0.5 mol% or more, the film deposition rate at the time of film forming is substantially within the range from 0.2 to 5 nm/sec, so that a nucleus for a columnar structure can be provided.

Please replace the paragraph, beginning at page 67, line 20, with the following rewritten paragraph:

The same effect can be obtained if the surface roughness Ra of the first under layer is set substantially within the range from 0.1 to 1.5 nm no matter what the material of the first under layer is, because the first under layer function as a nucleus for forming a columnar structure of the recording layer.

Please replace the paragraph, beginning at page 68, line 1, with the following rewritten paragraph:

The second under layer is formed on the first under layer, with the construction using fine surface irregularities having a roughness Ra set substantially within the range from 0.2 to 2 nm.

Please replace the paragraph, beginning at page 68, line 19, with the following rewritten paragraph:

Each of the magnetic layers forming the layers in the magneto-optical recording medium of the present invention can be made, for example, by a magnetron sputtering method using a target formed of a corresponding metallic material or an alloy target in which necessary materials are mixed and by the film forming Ar gas pressure, for example, substantially within the range from 0.5 to 2.0 Pa.

Please replace the paragraph, beginning at page 69, line 8, with the following rewritten paragraph:

For example, in a case where the Gd content ratio in GdFeCo is changed substantially within the range from 24 to 27%, a method of performing film forming by changing the film forming Ar gas pressure from substantially 1.2 to 0.4 Pa can be used.

Please replace the paragraph, beginning at page 71, line 7, with the following rewritten paragraph:

Even if the mark length is substantially 100 nm or less, there may be provided a high-density recording and reproduction process in which the stability of microscopic magnetic domains is improved, and information can be reproduced with stability from the reproduction layer after transfer into the reproduction layer can be performed. Even in such a case, the same or higher effects of the present invention can be achieved.